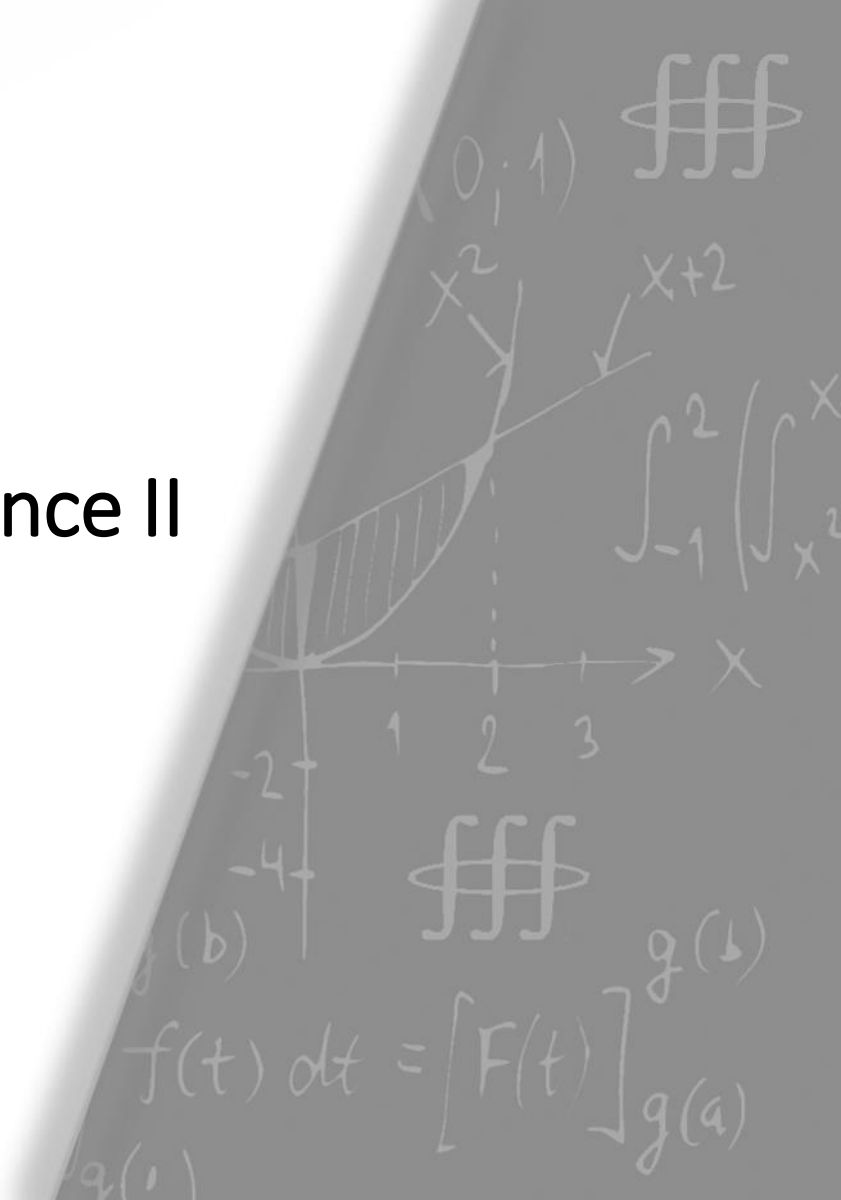
ITRI626 – Artificial Intelligence II

Vaal Triangle



Introduction

- In this session we will dive into what AI is at a high level
- We will look closer at machine learning and then deep learning
- We will identify the main paradigms of machine learning
- We will distinguish between types of learning
- We will introduce neural networks briefly

What is AI?

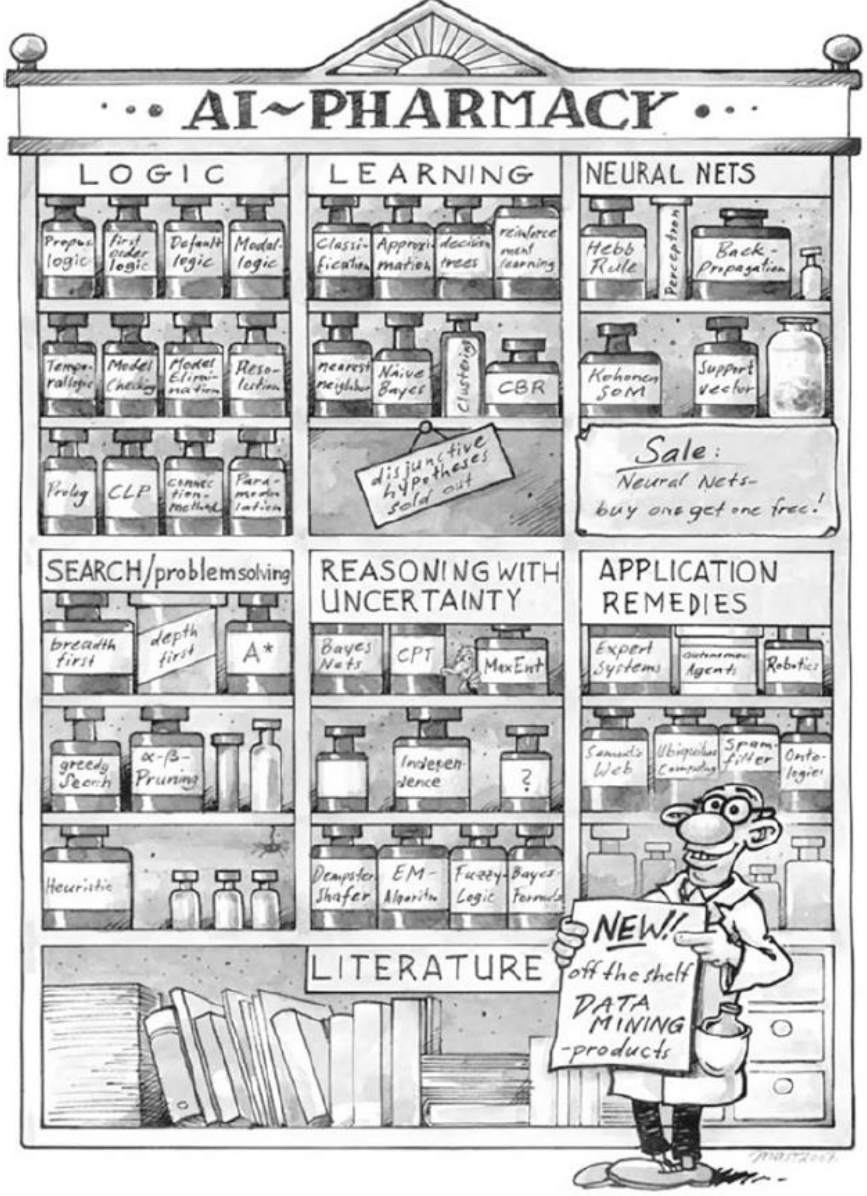
Russel & Norvig:

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

What is AI?

Ertel – Toolbox:

- Propositional Logic
- Predicate Logic (Application systems)
- Search/problem solving
- Reasoning under uncertainty
- Machine Learning
- Neural Networks



What is AI?

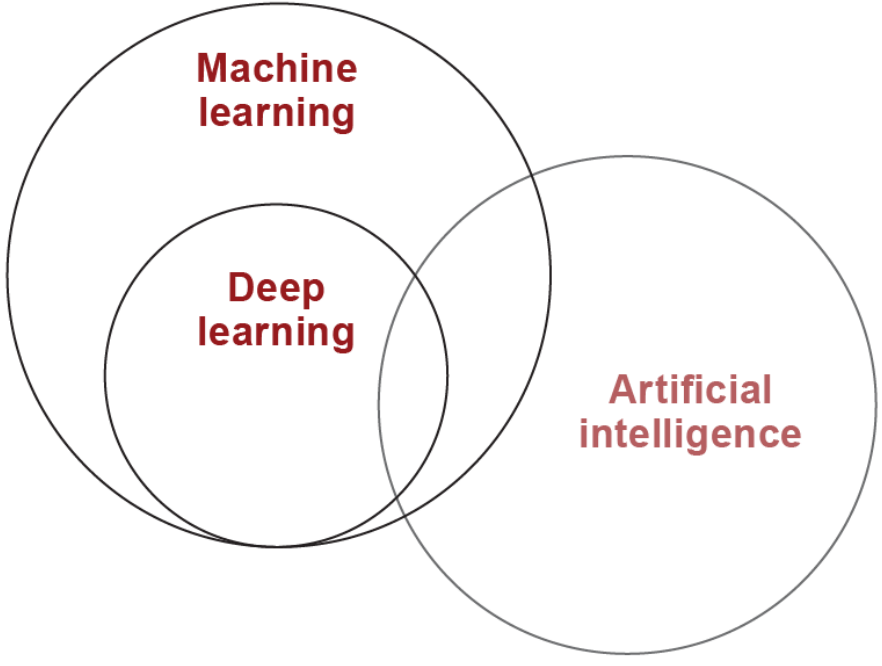
Luger – Application Areas:

- Game playing
- Automated reasoning and Theorem Proving
- Expert Systems
- Natural Language Processing, Understanding and Symantics
- Computer vision
- Modelling human performance
- Planning and robotics
- Languages and environments
- Machine Learning
- Alternative representations: Neural Nets and Genetic Algorithms
- AI and Philosophy

Where does Deep Learning fit?

Trask:

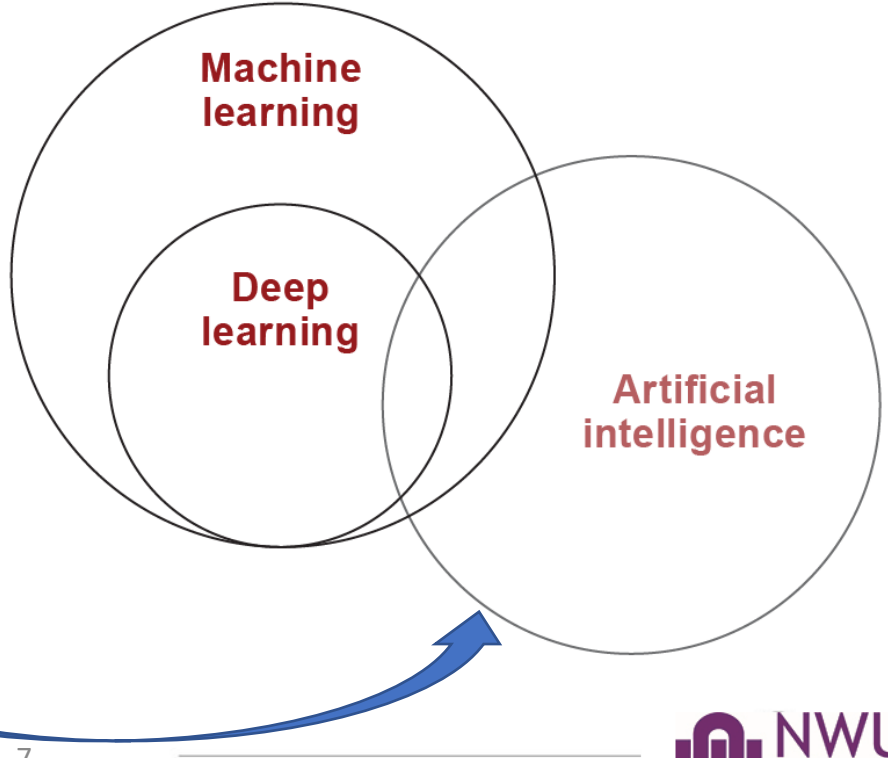
- Subset of Machine Learning



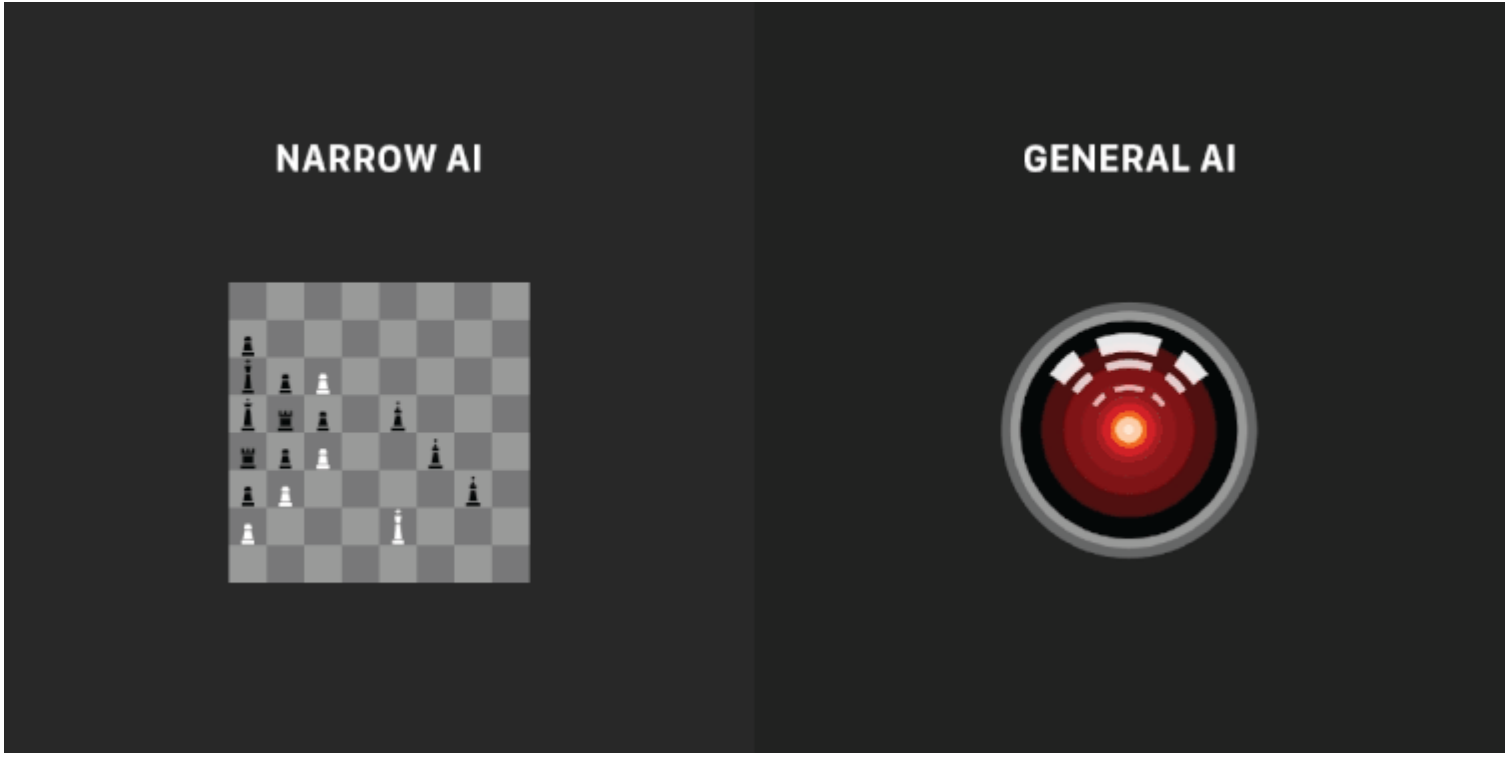
Where does Deep Learning fit?

Trask:

- Subset of Machine Learning
- Consider “Generalized AI”



Strong vs Weak AI = General vs Narrow AI



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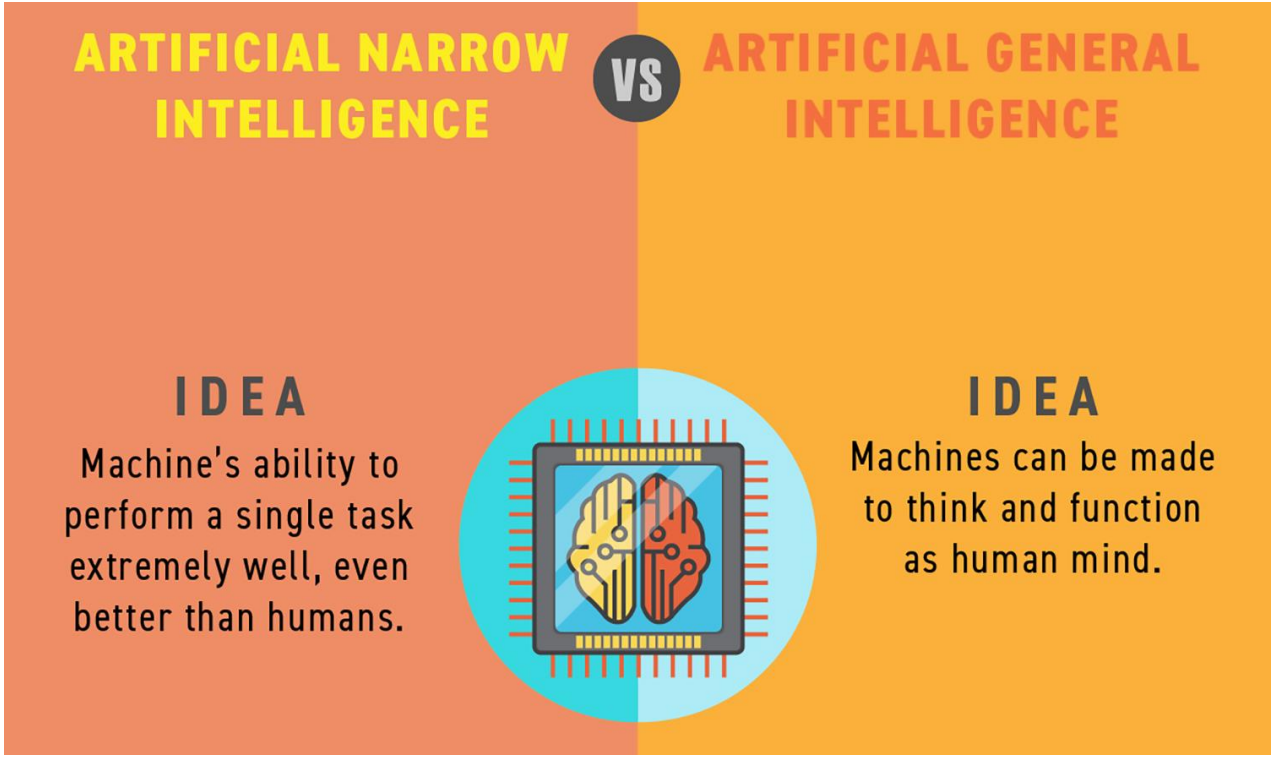


Strong vs Weak AI = General vs Narrow AI

General AI

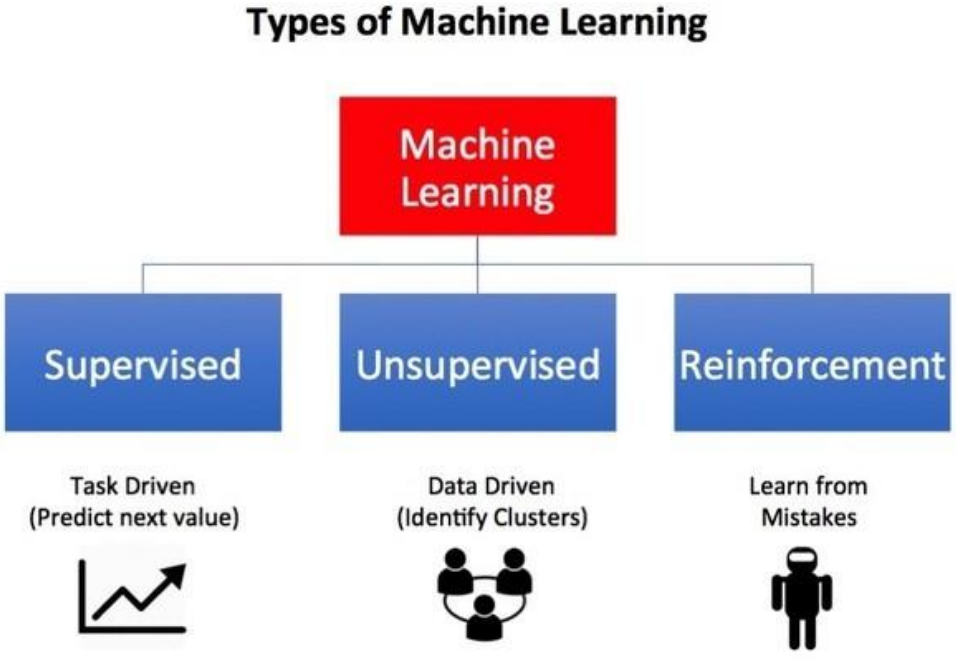
- Driven by scientists
- Multiple tasks
- Understanding

Narrow AI

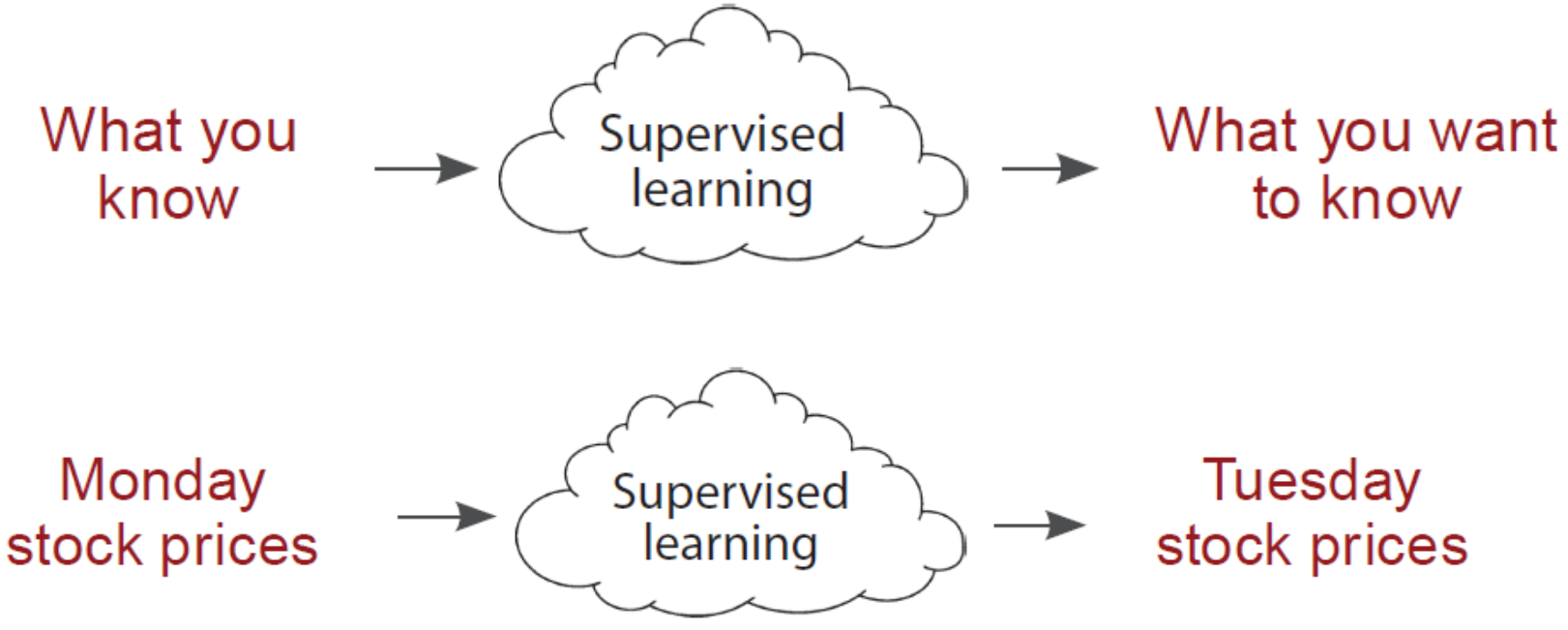
- Driven by Industry
- Single tasks
- Practical

Machine Learning – 3 Paradigms

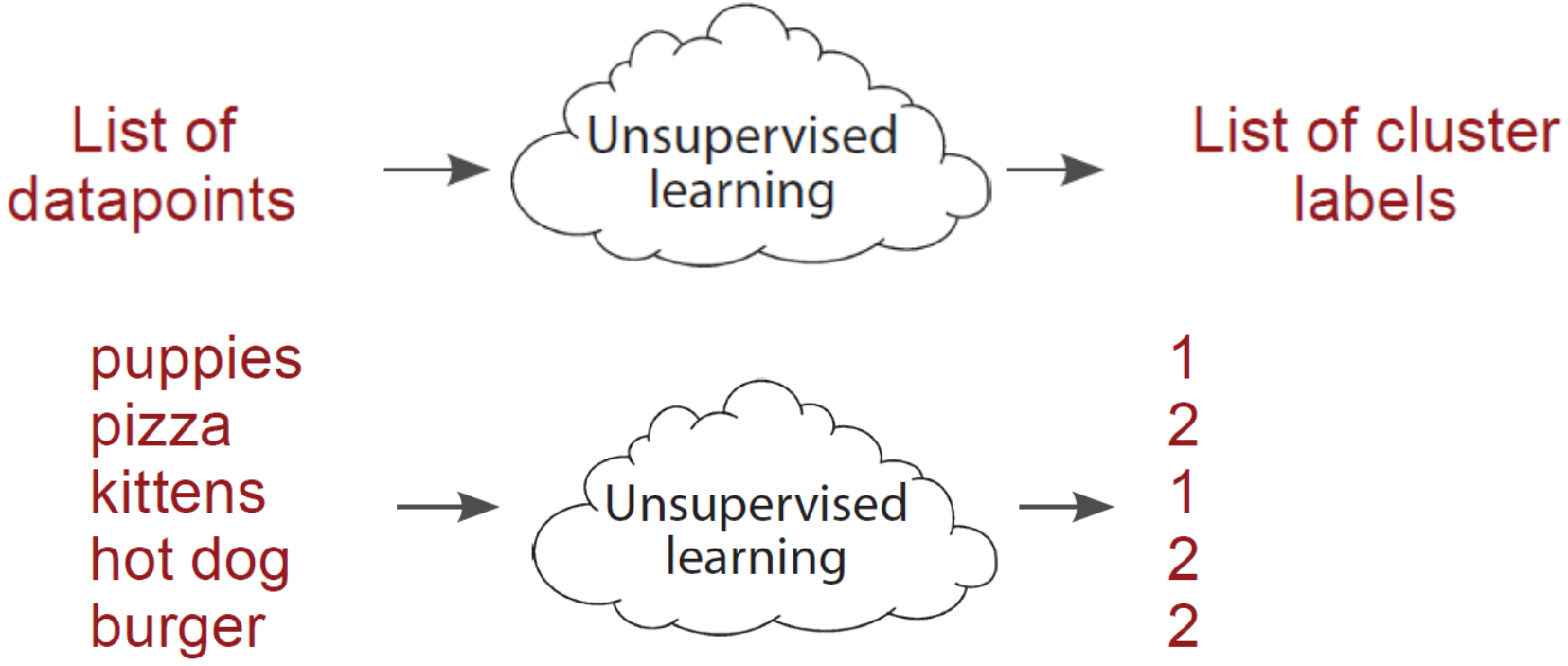
- Machine Learning has 3 main paradigms:



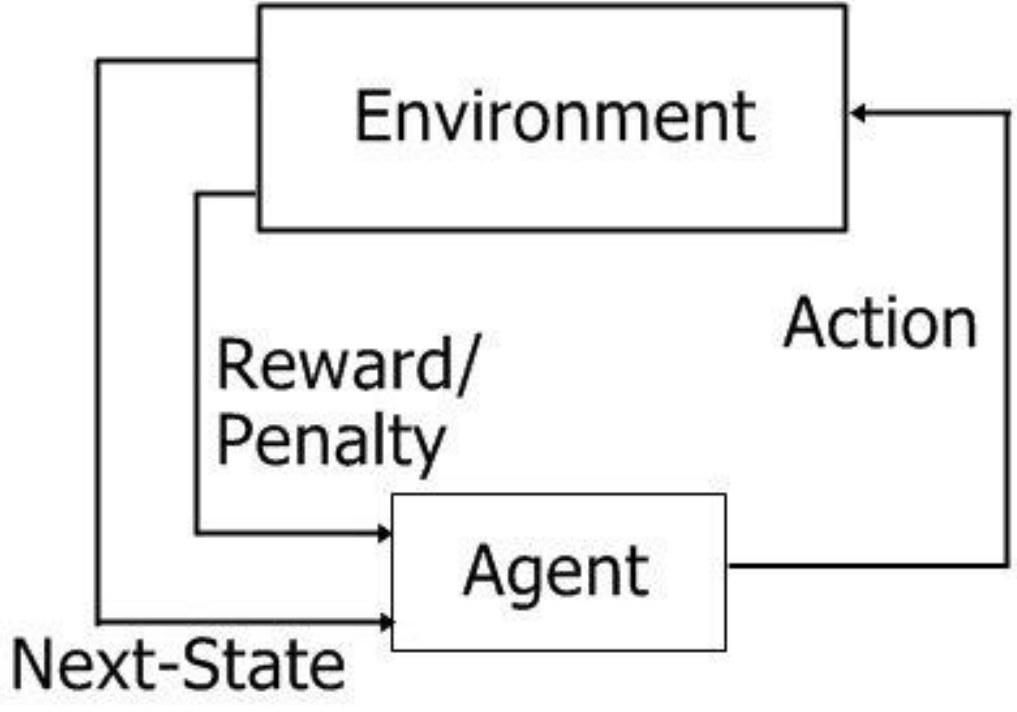
Machine Learning – Supervised Learning



Machine Learning – Unsupervised Learning

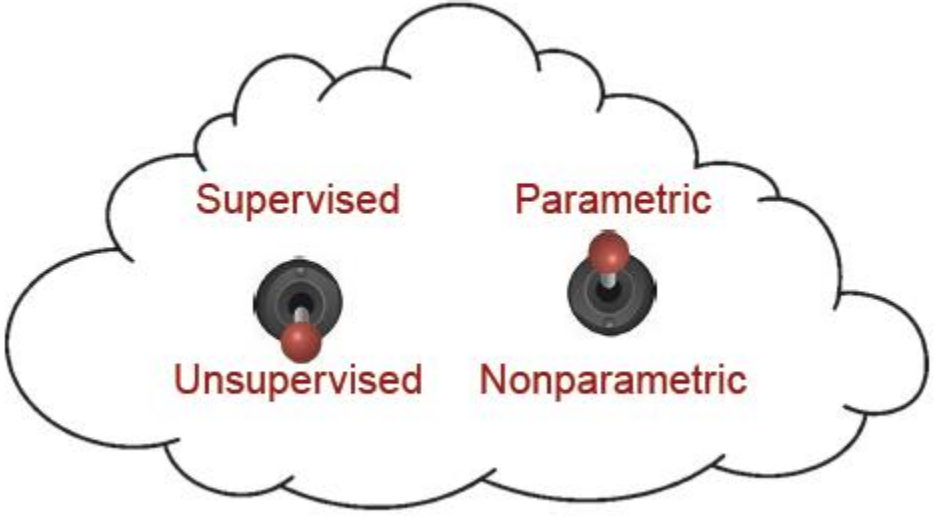


Machine Learning – Reinforcement Learning



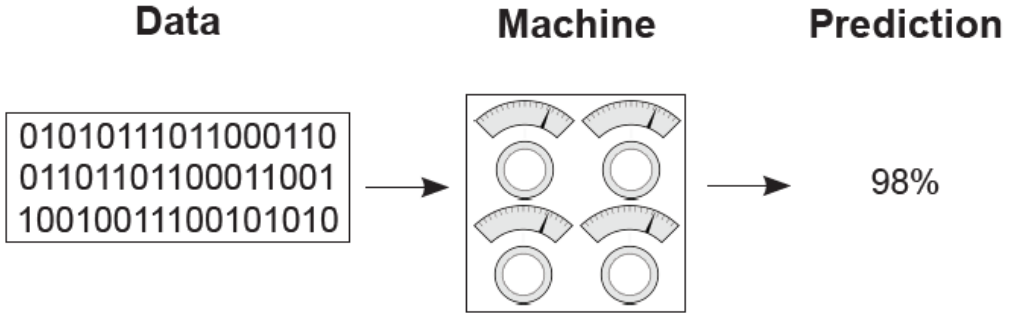
Machine Learning – classifying models

- In addition to the main paradigms, models can also be parametric or non-parametric. (in this course we will focus on supervised and unsupervised learning)



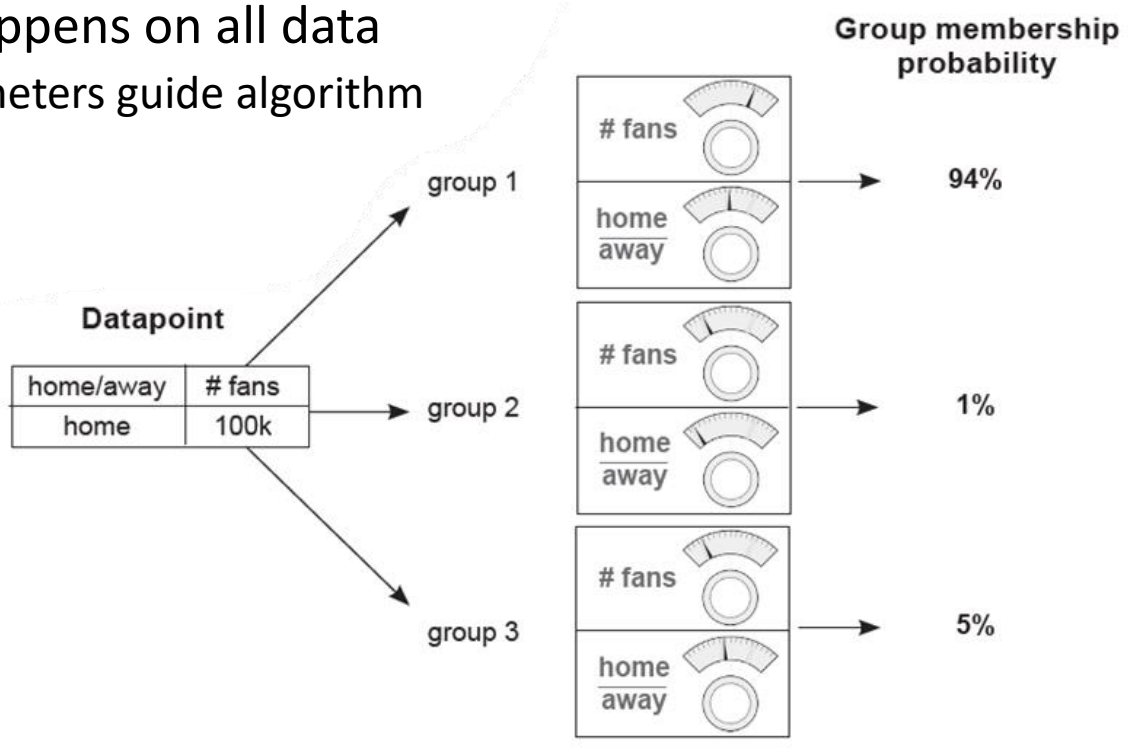
Supervised parametric learning

- Teaching this model type will have 3 steps in a loop:
  - Predict
  - Compare
  - Learn the pattern



Unsupervised parametric learning

- Clustering happens on all data
  - Meta parameters guide algorithm

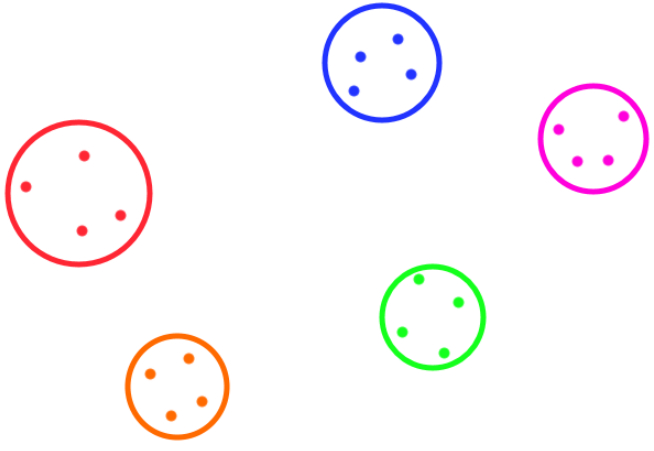


Non-parametric learning

- Data determines the number of parameters, possibly infinite
- Intuitive example of child's sorting cube toy:

Non-parametric learning

- Data determines the number of parameters, possibly infinite
- Example of the k-nearest neighbours algorithm



Python

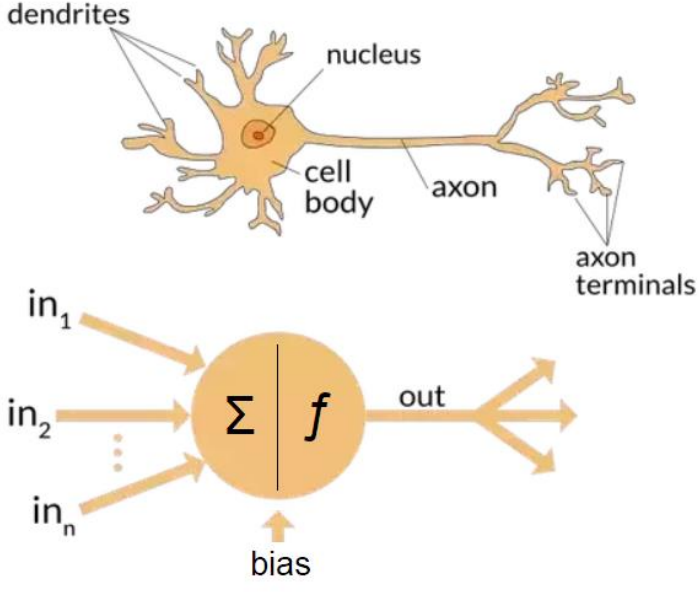
- I would encourage you to use Anaconda
- I would also encourage the use of jupyter notebook (but not prescribed)
- https://www.edx.org/course/introduction-to-python-absolute-beginner-5

Important points

- Definitions of AI
- Application areas of AI
- Types of AI
- Machine learning paradigms
- Parametric vs non-parametric learning

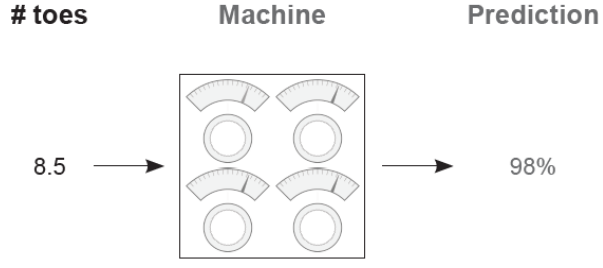
First Neural Network

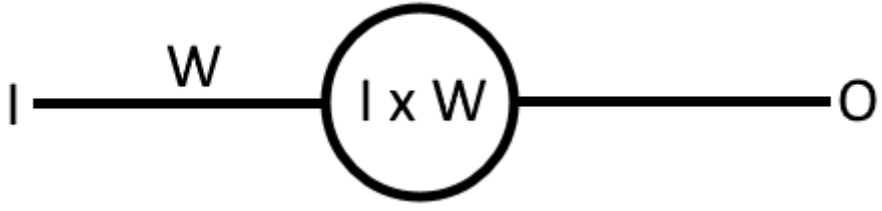
- Neural networks are modelled on the neurons in the human brain



First Neural Network – SISO

- In a mathematical sense, the first part of the operation that the neural network does is multiply input by some weight that is learned over time to create an output.
- Let us consider then what a single input, single output neural network in its simplest form can look like





*Switch to Python here

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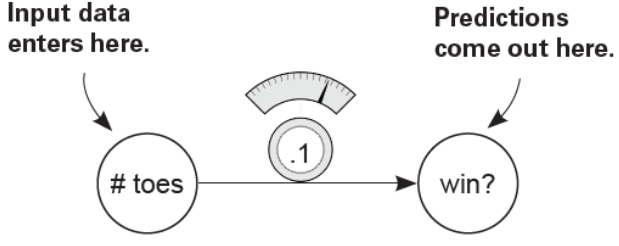

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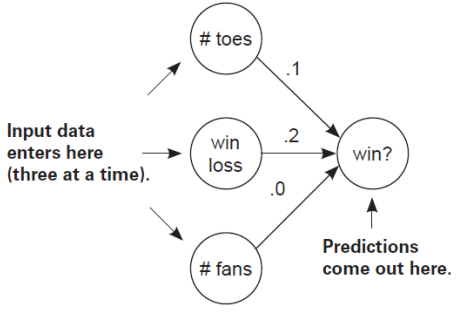
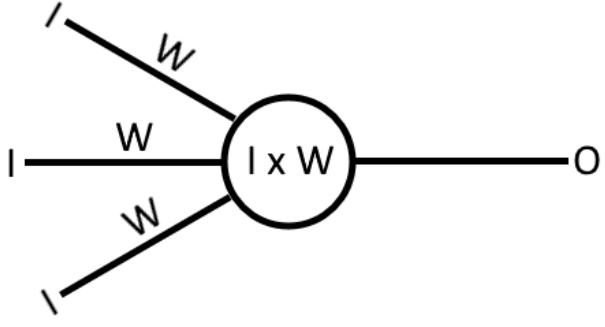
First Neural Network - MISO

- Next we consider what happens if we have multiple inputs – we will instead take a weighted sum by multiplying each input by its associated weight and summing the result
- Let us consider then what a multi input, single output neural network in its simplest form can look like





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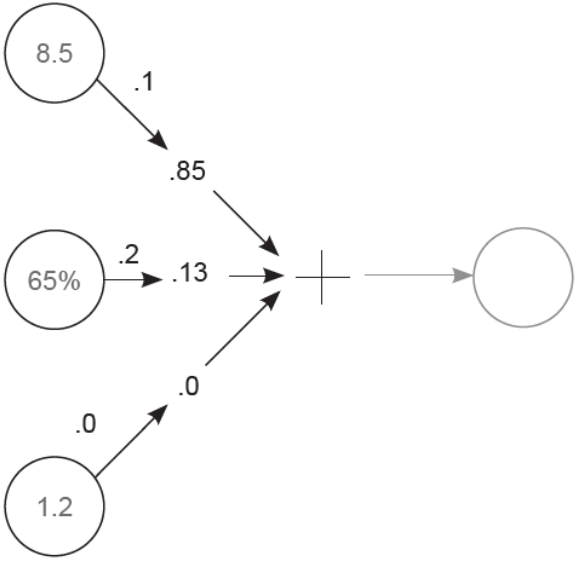
First Neural Network - MISO



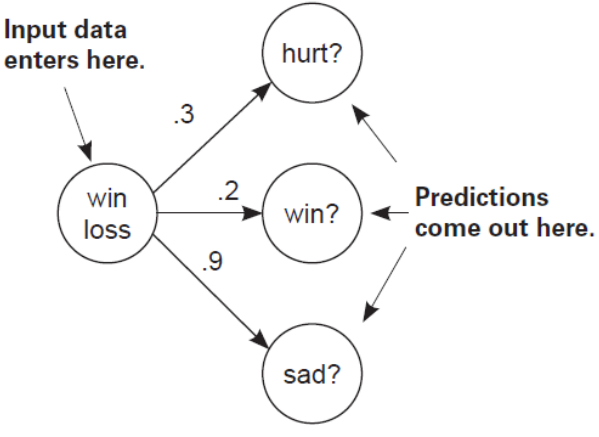
Inputs		Weights		Local predictions		
(8.50	*	0.1)	=	0.85	=	toes prediction
(0.65	*	0.2)	=	0.13	=	wlrec prediction
(1.20	*	0.0)	=	0.00	=	fans prediction

toes prediction + wlrec prediction + fans prediction = final prediction

0.85 + 0.13 + 0.00 = 0.98

First Neural Network - SIMO

- Multiple outputs are stacked on top of one another to take in the same inputs but use different weights



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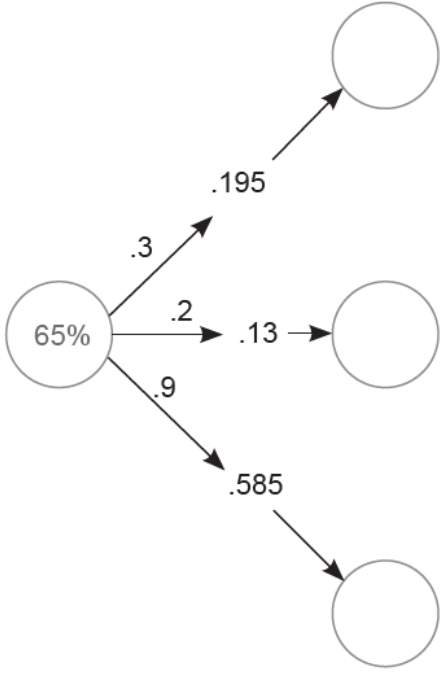
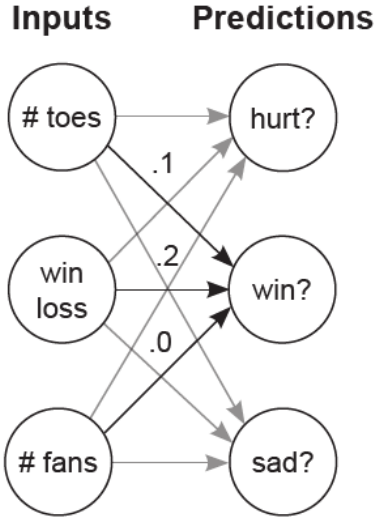
First Neural Network - SIMO



Inputs		Weights		Final predictions		
(0.65	*	0.3)	=	0.195	=	hurt prediction
(0.65	*	0.2)	=	0.13	=	win prediction
(0.65	*	0.9)	=	0.585	=	sad prediction

First Neural Network - MIMO

- Multiple outputs are stacked on top of one another to take in the same inputs but use different weights



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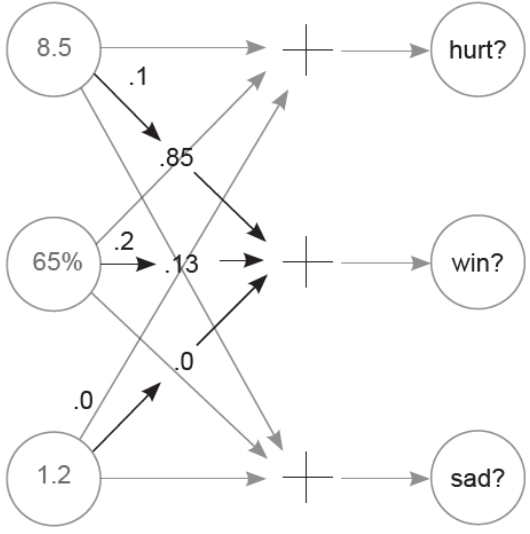
First Neural Network - MIMO



# toes		% win		# fans				
(8.5 * 0.1)	+	(0.65 * 0.1)	+	(1.2 * –0.3)	=	0.555	=	hurt prediction
(8.5 * 0.1)	+	(0.65 * 0.2)	+	(1.2 * 0.0)	=	0.98	=	win prediction
(8.5 * 0.0)	+	(0.65 * 1.3)	+	(1.2 * 0.1)	=	0.965	=	sad prediction

For Next Week

- Self-study: Chapter 1 (Introducing deep learning) of the Grokking Deep Learning e-book
- 25 March: Practical Quiz 1: Chapter 1 (Introducing deep learning) of the Grokking Deep Learning e-book

References

Trask, A. “Grokking deep Learning” 1st ed., Manning 2019

Ertel, W. “Introduction to Artificial Intelligence” 2nd ed., Springer 2017

Russel,R. Norvig, P. “Artificial Intelligence A modern Approach” 3rd ed., Prentice Hall 2010

Luger, G. “Artificial Intelligence: Structures and Strategies for Complex Problem Solving” 6th ed., Pearson 2009

Mind map from: www.machinelearningmastery.com

https://analyticsindiamag.com/artificial-narrow-vs-artificial-general/

https://towardsdatascience.com/what-are-the-types-of-machine-learning-e2b9e5d1756f

Lall, Snehalika & Sadhu, Arup Kumar & Konar, Amit & Mallik, Kalyan & Ghosh, San. (2016). Multi-agent Reinfocement Learning for Stochastic Power Management in Cognitive Radio Network.